Note: This document describes the development of preliminary nutrient targets for TMDLs in nutrient-impaired segments of the Floyds Fork watershed. The document establishes the rationale, approach, framework, and initial values for targets. The document was sent to EPA in October 2011 for review.

Floyds Fork Nutrients TMDL
Applicable water quality standards and water quality targets
October 21, 2011

Kentucky regulations establish the authority to limit nutrient discharges in waters where increased nutrients (i.e., eutrophication) cause problems, with certain considerations.

401 KAR 10:31. Surface water standards.

Section 1. Nutrient Limits. In lakes and reservoirs and their tributaries, and other surface waters where **eutrophication problems** may exist, nitrogen, phosphorus, carbon, and contributing trace element discharges shall be limited in accordance with:

(1) The scope of the problem;
(2) The geography of the affected area; and
(3) Relative contributions from existing and proposed sources.

Narrative criteria applicable to all waters reference several indicators of impairment that can be caused by increased nutrients, such as excessive algal growths and unbalanced aquatic communities. Water quality criteria for warm water aquatic habitat and coldwater aquatic habitat include numeric standards for dissolved oxygen.

Section 2. Minimum Criteria Applicable to All Surface Waters.

(1) The following minimum water quality criteria shall be applicable to all surface waters including mixing zones, with the exception that toxicity to aquatic life in mixing zones shall be subject to the provisions of 401 KAR 10:029, Section 4. Surface waters shall not be aesthetically or otherwise degraded by substances that

(a) Settle to form objectionable deposits;
(b) Float as debris, scum, oil, or other matter to form a nuisance;
(c) **Produce objectionable color, odor, taste, or turbidity**;
(d) **Injure,** are chronically or acutely toxic to or **produce adverse physiological or behavioral responses in humans, animals, fish, and other aquatic life;**
(e) **Produce undesirable aquatic life or result in the dominance of nuisance species;**

Section 4. Aquatic Life.

(1) Warm water aquatic habitat. The following parameters and associated criteria shall apply for the protection of productive warm water aquatic communities, fowl, animal wildlife, arboreous growth, agricultural, and industrial uses:

…

(e) Dissolved oxygen.

1.a. Dissolved oxygen shall be maintained at a minimum concentration of five and zero-tenths (5.0) mg/l as a twenty-four (24) hour average in water with WAH use;

b. The instantaneous minimum shall not be less than four and zero-tenths (4.0) mg/l in water with WAH use.

…

(2) Cold water aquatic habitat. The following parameters and criteria are for the protection of productive cold water aquatic communities and streams that support trout populations, whether self-sustaining or reproducing, on a year-round basis. The criteria adopted for the protection of warm water aquatic life also apply to the protection of cold water habitats with the following additions:

(a) Dissolved oxygen.

1. A minimum concentration of six and zero-tenths (6.0) mg/l as a twenty-four (24) hour average and five and zero-tenths (5.0) mg/l as an instantaneous minimum shall be maintained.

Interpretation of narrative water quality criteria

Kentucky interprets the narrative criteria in Sections 1 and 2 to include impairments related to excessive benthic, suspended, or floating algae or aquatic plants, low concentrations or large fluxes of dissolved oxygen, and low biological integrity of macroinvertebrate, fish, and algal communities. Kentucky does not have specific quantitative guidelines for what is considered to be excessive algae or plant growth; such conditions are judged during site visits by field personnel who typically make note when benthic, suspended or floating algae/plants are present to a level that is likely to affect biota or interfere with recreation. Some monitoring programs do include specific observations pertaining to algae on their field forms where personnel can record the presence of algae mats, turbid conditions due to suspended algae, or the extent of coverage of algal mats of different types.

Biological integrity in headwater and wadeable streams is assessed by KDOW using multimetric indices and indicator metrics that summarize numerous aspects of community composition: the Macroinvertebrate Bioassessment Index (MBI), the Kentucky Index of Biotic Integrity (KIBI) and the Diatom Bioassessment Index (DBI). Index scores for each index are translated to a narrative rating (Excellent, Good, Fair, Poor) based on expectations relative to the least disturbed streams in the respective bioregion. Excellent and Good scores are generally deemed to be evidence that aquatic life use is fully supported. Often, two or more assemblage types are measured at a visit and these are weighed along with supporting data to derive a final narrative rating. When assessing biological integrity, headwater streams (<5 square miles catchment area) are scored separately from larger wadeable streams because of different expectations for community composition. There is no specific catchment area cutoff for wadeable versus non-wadeable streams. In a given watershed, streams may be considered wadeable up to 100-200+ square miles catchment area, depending on depth, width, and flow characteristics. The physical differences in the transition from wadeable to nonwadeable are important in selecting methodology and in weighing supplemental information for assessing aquatic life use. Larger streams that are not wadeable are also referred to as boatable streams, reflecting the increased importance of recreation on these streams, in addition to larger stream order and size (depth and typically width). Kentucky does not yet have biological indices for non-wadeable/boatable streams, but where appropriate some large “transitional” size streams are assessed using the wadeable streams indices, supplemented by other information.

General Derivation of targets

The best available information is used to derive nutrient targets for TMDLs. Usually, weighing several candidate targets derived from different approaches will ensure that targets confidently represent a condition where water quality standards are being met. The strongest information for setting targets is watershed-specific empirical data, studies, experiments, or models relating nutrients to the specific indicators of impairment that have been observed in the watershed for which the TMDL is being developed. Often such information is not available and empirical data from a broader region must be considered. Such empirical data does not always yield clear relationships, however, and care must be taken to ensure that regional information is comparable. For both watershed-specific and regional empirical data, the presence of additional stressors other than the one of interest can complicate the interpretation of relationships.

A second complementary approach is to examine nutrient distributions from a large number of sites assessed as fully meeting uses. If the set of assessed streams represents the full range of nutrient conditions present in the region then an upper range of this distribution (e.g. 75th percentile) may serve as a candidate target. One limitation of this approach is that often sites assessed using biological community information have only one-time grab samples associated with them, which reduces confidence in extrapolating the target beyond the sampling season.

A watershed reference approach may be feasible if there are specific streams within the TMDL watershed that have been assessed as fully supporting the use and that have substantial nutrient data. Candidate targets based on watershed reference are most powerful when the selected references fully reflect local watershed features and stream types and have several years of nutrient data collected throughout the year or the growing season. If no streams in the watershed are confidently supporting the use, other closely comparable streams in the region may be selected. Nutrient data for watershed reference streams can be summarized to develop a target profile of nutrient conditions expected to be consistent with meeting narrative water quality standards. It is important that watershed reference streams have been assessed using similar indicators as the indicators of concern in the watershed for which the TMDL is being developed.

In weighing candidate nutrient targets for TMDLs, it is important to take into account natural background nutrient inputs across the watershed. Accounting for natural background phosphorus is especially important in setting realistic expectations across many areas of Kentucky because of the prevalence of high phosphorus-content limestone formations. Natural background is difficult to estimate in areas that have experienced substantial human activities and where no minimally disturbed areas still exist. KDOW's Reference Reach network provides information on typical nutrient concentrations in the least disturbed streams in a region, and may serve as the best available estimate of background nutrients.

In large watersheds, it may be appropriate to set more than one nutrient target, depending on within-watershed differences that may influence the effects of nutrients. Stream size is an important consideration because differences in light, water depth substrate, flow, and resident biota in small versus larger streams may result in different effects on benthic algae and biological communities at similar nutrient concentrations. For example, in small headwater streams low flows may allow for buildup of algae and organic material which can affect biological communities that are sensitive to habitat smothering. In contrast, larger non-wadeable streams with long, sunny, slow moving pools may experience excessive growth of suspended algae and large diurnal swings in dissolved oxygen. Frequent moderate to high flow periods in larger streams may minimize the establishment of extensive algal mats in riffles. These potential differences in nutrient effects suggest that different nutrient targets for different segments should be considered in TMDLs encompassing large watersheds.

Floyds Fork Nutrient Target development:

For Floyds Fork, targets have been selected to prevent nuisance benthic algae growths and reduced biological integrity. Nuisance benthic algae (mainly *Cladophora*) have been reported historically in several tributaries, including Chenoweth Run (KDOW 1999) and Curry's Fork (KDOW 1986). Recent data on algal nuisances in the watershed is sparse but many tributaries with elevated nutrients likely exhibit dense algal growths in the early part of the growing season. Although there are no specific guidelines for what is excessive benthic algae, where algal mats

cover substantial portions of riffles for extended periods of time they can be considered an indicator of impairment, especially when coincident with reduced biological integrity. Reduced biological integrity has been reported in several tributaries in the form of Fair or Poor scores on biological indices, particularly the Macroinvertebrate Bioassessment Index (KDOW EDAS database). In many parts of the Floyds Fork watershed, both TP and TN are elevated above concentrations typical of regional Reference Reach streams and other streams previously assessed as supporting their uses. Therefore, both TP and TN are presumed to be at least in part contributing to the observed impairments and will receive targets.

The Floyds Fork watershed is approximately 284 square miles in catchment area. Because of its large size, streams in the Floyds Fork watershed have been classified into three size groups to be assigned a separate set of nutrient targets. These size categories reflect potential differences in the response of biota to nutrient enrichment. Streams with <5 square miles of catchment area have been placed in the headwater size category, in keeping with the classification used in scoring the Macroinvertebrate Bioassessment Index. Headwater streams tend to have low or no flow during much of the late summer and fall, which affects many aspects of the biological communities and impacts the time periods for monitoring, with biological sampling typically performed March-May. Streams with catchment area >5 square miles have been placed in the wadeable category, except for portions of the main stem of Floyds Fork. In general, wadeable streams maintain flow all or most of the year and biology is typically sampled May-September. The mainstem of Floyds Fork up to the confluence with Upper Chenoweth Run (at mile point 40.1) has been placed in a transitional/boatable size category. This section of Floyds Fork is characterized by long, deep pools and infrequent riffles. It is the section of Floyds Fork most frequently used for recreation by kayakers and canoeists.

For all size categories, watershed-specific empirical data for Floyds Fork is limited. Candidate targets were derived and weighed using multiple approaches, including regional empirical data, nutrient distributions of regional biologically healthy sites, watershed reference nutrient conditions, and relevant literature. For regional-based approaches, the region was defined as either ecoregion 71d (Outer Bluegrass) or the larger Bluegrass bioregion, which incorporates ecoregions 71d, 71k (Hills of the Bluegrass) and 71l (Inner Bluegrass). The entire bioregion was considered when evaluating regional empirical data relationships, but because of differences in background nutrient concentrations among ecoregions, only 71d was considered for distribution-based approaches. A small (~5 square miles) area in the southwestern portion of the Floyds Fork watershed, mainly encompassing headwater size sections of Bluelick Creek, falls across the boundary for ecoregion 71c (Knobs-Norman Upland). Available information is not sufficient to evaluate whether this small area should have separate nutrient targets.

Headwater sections

Recent analyses of regional empirical data have shown generally poor resolution of nutrient effects in the Bluegrass region. When separated by size category, however, headwater streams appear to show somewhat more distinct trends with respect to nutrients than non-headwater wadeable streams (Figure 1). Because of low sample size and high variability in the regional empirical dataset, confidence in a specific threshold is low, but trends suggest that in the range 0.100 - 0.200 mg/L TP and 0.8 and 1.5 mg/L TN there may be reduction in several macroinvertebrate metrics below expectations.

An additional line of evidence used in deriving nutrient targets for the headwater size category was to examine nutrient distributions from similar biologically healthy sites (i.e., sites assessed to be supporting aquatic life use using a biologically-based assessment method). Headwater

sites in the same ecoregion (71d, Outer Bluegrass) were chosen as the most comparable. Nutrient data from all streams with a MBI score of Good or Excellent were summarized and the 75th percentile of TN and TP values was chosen as a conservative estimate of the upper range of nutrients in "healthy" sites in the ecoregion. The resulting values were 0.085 mg/L TP and 0.638 mg/L TN (Table 1). These values were slightly above or similar to estimated background based on the 75th percentile of Reference Reach samples from 71d headwaters (0.079 mg/L TP and 0.600 mg/L TN; Table 2).

There are no headwater size streams in the Floyds Fork watershed that have been assessed as fully supporting aquatic life use that included a biologically-based assessment method. Additionally, nutrient data for headwater streams is generally limited to one-time grab samples and so use of a headwater reference either in Floyds Fork or in a nearby watershed was not feasible or useful.

A frequently cited literature threshold was considered in weighing the above candidate targets that recommends 0.1 mg/L TP as being a target for preventing nuisance benthic algae in streams (USEPA 1986). This recommendation supports a TP target similar to the healthy sites candidate target, since benthic algae are anecdotally reported to be problematic in headwater streams in the Floyds Fork watershed. A stream trophic classification recommended by Dodds et al (1998) also was considered in weighing targets. The candidate targets described above roughly correspond to the mesotrophic-eutrophic boundary given for TP of 0.075 mg/L. However, the candidate targets for TN are closer to the oligotrophic-mesotrophic boundary. Without more detailed information on interactions between nitrogen and phosphorus in Floyds Fork headwater streams, a conservative approach was chosen to keep the TN target near the lower boundary.

Final targets of 0.09 mg/L TP and 0.7 mg/L TN were selected to be applied as an annual geometric mean. An annual averaging period was chosen for this size class rather than the growing season because often these headwater streams do not flow beyond June or July and the number of months with data would be limited. Targets should not be exceeded more than once in a three-year period. The three year exceedence frequency is based on a general guideline for ensuring ecosystem recovery following a variety of stressors (EPA 1994). To limit infrequent but very large excursions a maximum annual geometric mean never to be exceeded was derived from the maximum concentration observed at Reference Reach headwater sites in the ecoregion, 0.12 mg/L TP and 1.0 mg/L TN (Table 2).

Wadeable sections

As discussed above, non-headwater size wadeable streams have yielded poor empirical relationships with nutrients (Figure 1). A "healthy sites" distribution (see description of approach in headwater section above) from wadeable streams in ecoregion 71d was selected as the best approach to deriving targets. The 75th percentiles were 0.147 mg/L TP and 1.140 mg/L TN (Table 1).

There are no wadeable size streams in the Floyds Fork watershed that have been assessed as fully supporting aquatic life use that included a biologically-based assessment method. Use of a watershed reference for the wadeable category either in Floyds Fork or in a nearby watershed was not feasible.

Final targets of 0.15 mg/L TP and 1.1 mg/L TN were selected to be applied as a growing season geometric mean. The growing season period (April-October) was chosen for this size class

because that is the time period when the risk of nutrient-related effects is judged to be greatest, and most of the data used to derive the targets were collected during that period. Targets are not be exceeded more than once in a three-year period. The three year exceedence frequency is based on a general guideline for ensuring ecosystem recovery following a variety of stressors (USEPA 1994). To limit infrequent but very large excursions a maximum growing season geometric mean never to be exceeded was derived from the maximum concentration observed at Reference Reach wadeable sites in the ecoregion, 0.25 mg/L TP and 1.6 mg/L TN (Table 3).

Transitional/boatable sections

The transitional/boatable category is the only size category for which there was a segment within the Floyd Fork watershed confirmed to be fully supporting aquatic life use using bioassessment methods. KDOW maintains a monitoring station at KY1526 in the lower part of Floyds Fork. This station was sampled for biology 1999, 2004 and recently in 2011 with narrative rating Good or Excellent for all assemblages scored. Nutrients have been sampled bimonthly or monthly since 1999 at this location or at a nearby location (at KY44) and field observations were recorded at most of these visits. Algal mats were reported on just two occasions. In 2010 and 2011, several samples were collected for water column chlorophyll-*a* at the KY44 location with maximum of 8.5 µg/L (Table 5), well below the level of 20-30 µg/L generally considered to indicate nuisance suspended algae. Because of this strong evidence of use support, we were able to use this segment as a watershed reference for stream segments in this size category. A growing season geometric mean was calculated for TN and TP for each year 1999-2009. Growing season was chosen for this category because that is the time of year when lower flows and warm water temperatures allow for the greatest risk of nutrient effects. The maximum geometric mean from this period was chosen for the target due to the relatively small time frame (11 years). This value was 0.198 mg/L T and 2.191 mg/L TN (Table 4).

A maximum growing season geometric mean never to be exceeded was identified by examining nutrient data from the same time period in two other boatable size streams comparable to Floyds Fork, Beech Fork and Brashears Creek. These two streams have been assessed as fully supporting aquatic life use. The maximum growing season geometric means for TP and TN from 1999-2009 in the two streams were observed in Brashears Creek, 0.663 mg/L TP and 2.436 mg/L TN (Tables 6 and 7).

Final Targets Summary

Final targets for stream size categories:

Size category	TP target	TP max	TN target	TN max
Headwater (<5 sq mi)	0.09	0.12	0.70	1.0
Wadeable (5-100 sq mi)*	0.15	0.25	1.1	1.6
Transitional/Boatable (>100 sq mi)**	0.20	0.66	2.2	2.4

* includes tributaries in that size range and Floyds Fork mainstem above Upper Chenoweth Run
** includes mainstem of Floyds Fork downstream of Upper Chenoweth Run

In headwater sections of the watershed, the target is to be applied as an annual geometric mean. In wadeable and transitional/boatable sections, the target is to be applied as a growing season (April-October) geometric mean. In all sections the target is not be exceeded more than once in every three years, and the maximum is never to be exceeded as an annual or growing season geometric mean. These targets are to apply everywhere within the respective stream size categories.

The nutrient targets presented here are subject to change as new information is made available. In particular, new bioassessments and nutrient monitoring throughout Floyds Fork and the region, planned for 2012, may produce information to refine these nutrient targets to better account for watershed-specific characteristics and their influence on nutrient effects. Also, additional monitoring data may provide a stronger basis for the averaging periods, exceedence frequencies, and maximum excursions.

Literature Cited

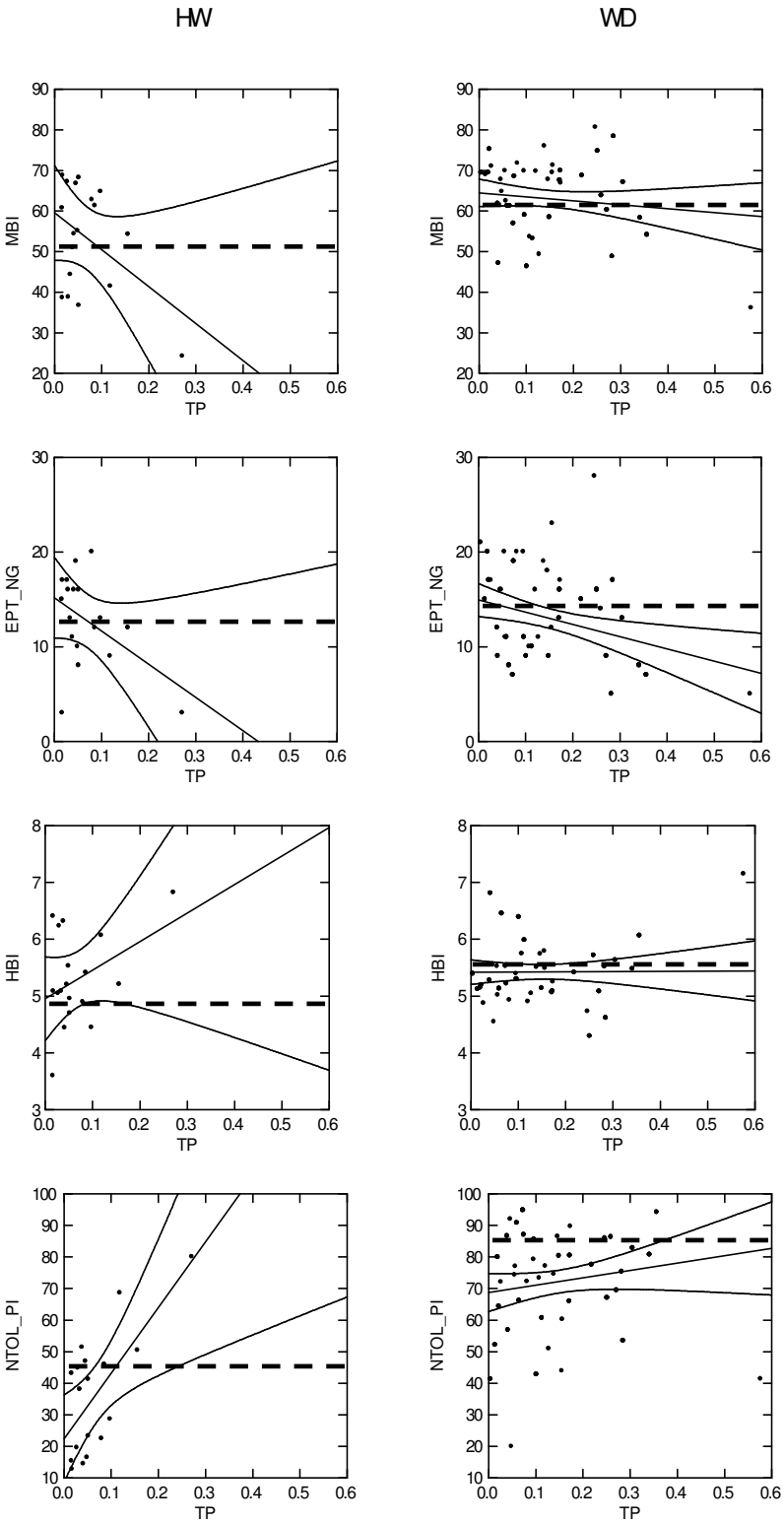
Kentucky Division of Water 1986. Floyds Fork drainage biological and water quality investigation for stream use designation. Technical Report No. 3.

Kentucky Division of Water 1999. Chenoweth Run Biological and Water Quality Investigation. Technical Report No. 54.

U.S. Environmental Protection Agency 1986. Quality criteria for water: EPA-44-/5-86-001.

U.S. Environmental Protection Agency 1994. Water Quality Standards Handbook: Second Edition. EPA-823-B-94-005.

Figure 1. MBI, Hilsenhoff Biotic Index, EPT Genus Taxa, % Nutrient Tolerant Individuals plotted against TP and TN (mg/L), for Headwater (HW) and wadeable (W) size categories. Linear smoother with 95% confidence interval is included. Dashed lines represent Fair-Good boundary (MBI), metric 90th percentiles (HBI, %Nutrient Tolerant) or metric 10th percentiles (EPT Genus Taxa) from Bluegrass Reference Reaches.



HW WD

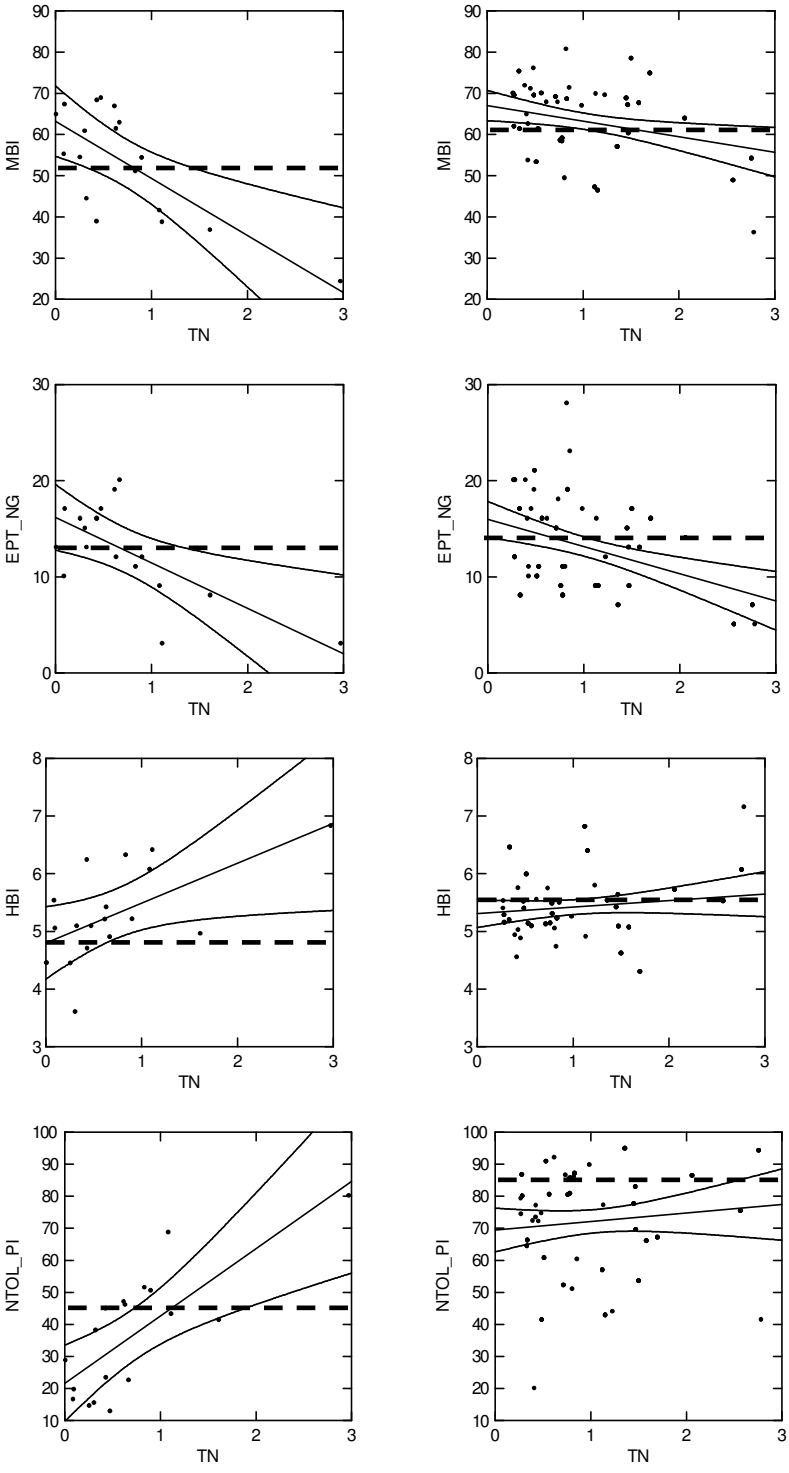


Table 1. Ecoregion 71d Biologically healthy sites

Samples	StationID	StreamName	CollDate	CA	Ecoreg	Program	MBI	Rating	TP	TN
1	DOW08057003	CORN CREEK UT	4/11/2002	0.95	71d	REF	60.7	Excellent	0.017	0.315
1	DOW12012006	GUIST CREEK UT to UT	4/7/2004	1.4	71d	PRB	54.2	Good	0.157	0.909
1	DOW12031001	GRAVEL CREEK	4/8/2004	1.6	71d	PRB	68.7	Excellent	0.018	0.482
1	DOW08074005	SECOND CREEK	4/21/2004	2	71d	PRB	62.7	Excellent	0.080	0.676
1	DOW08074003	SECOND CREEK	4/15/2003	2.2	71d	REF	54.3	Good	0.042	0.265
1	DOW08073003	ASHBYS FORK	5/7/2009	2.2	71d	REF	64.7	Excellent	0.099	0.116
1	DOW08068005	LITTLE SOUTH FORK	4/29/2004	2.4	71d	PRB	66.7	Excellent	0.047	0.625
1	DOW08074002	GARRISON CREEK	5/12/2009	4.5	71d	REF	68.1	Excellent	0.052	0.440
1	DOW04007003	INDIAN CREEK	3/25/2003	5.6	71d	REF	64.7	Good	0.049	0.419
1	DOW08077002	PLEASANT RUN CREEK	7/9/2004	9.7	71d	PRB	61.2	Good	0.066	0.347
2	DOW12004001	CEDAR CREEK	6/1/2009, 6/29/2009	12.2	71d	REF	69.4	Good	0.013	0.445
1	DOW05015001	TOWNSEND CREEK	7/1/2004	16.3	71d	PRB	67.7	Good	0.147	0.743
1	DOW12028012	CURRYS FORK	10/26/2009	23	71d	PRB	67.5	Good	0.172	1.591
1	DOW08073015	WOOLPER CREEK	7/21/2009	23.6	71d	PRB	61.8	Good	0.040	0.289
1	DOW05016030	GRASSY LICK CREEK	7/21/2004	41.22	71d	PRB	69.4	Good	0.156	1.235
1	DOW05029035	FLEMING CREEK	7/8/2004	62.238	71d	PRB	69.7	Excellent	0.121	1.140
1	DOW12051001	HARRODS CREEK	10/27/2009	68	71d	PRB	69.0	Good	0.015	0.723
1	DOW12009001	BULLSKIN CREEK	6/28/2004	75	71d	PRB	68.7	Good	0.219	1.459
1	DOW12022007	CARTWRIGHT CREEK	8/25/2009	82	71d	PRB	61.2	Good	0.061	0.541
1	DOW05032009	SLATE CREEK	7/6/2004	169	71d	PRB	71.0	Excellent	0.027	0.461
1	DOW05032010	SLATE CREEK	7/6/2004	215	71d	PRB	75.2	Excellent	0.023	0.342
							HW	max	0.157	0.909
								75th	0.085	0.638
							W	max	0.219	1.591
								75th	0.147	1.140

Table 2. Reference Reach monitoring nutrient data, ecoregion 71d, headwater streams, all sample events

Headwater:

Program	Station	Stream	Mile	CA	Ecoreg	CollDate	TP mg/L	TN mg/L
REF	DOW08057003	CORN CREEK UT	0.6	0.95	71d	5/18/2004	0.0515	0.693
REF	DOW08057003	CORN CREEK UT	0.6	0.95	71d	4/17/2009	0.0226	0.972
REF	DOW08057003	CORN CREEK UT	0.6	0.95	71d	4/11/2002	0.017	0.315
REF	DOW08066001	BIG SUGAR CREEK UT	1.1	2.18	71d	4/20/2004	0.059	0.1306
REF	DOW08066001	BIG SUGAR CREEK UT	1.1	2.18	71d	5/7/2009	0.109	0.469
REF	DOW08073003	ASHBYS FORK	2	2.2	71d	5/7/2009	0.0988	0.1158
REF	DOW08074003	SECOND CREEK	0.35	2.2	71d	4/15/2003	0.042	0.265
REF	DOW08074003	SECOND CREEK	0.35	2.2	71d	4/28/2009	0.058	0.4203
REF	DOW08074003	SECOND CREEK	0.35	2.2	71d	4/7/2004	0.0345	0.332
REF	DOW08073004	DOUBLE LICK CREEK	0.07	2.31	71d	4/28/2009	0.0773	0.1529
REF	DOW08074004	GARRISON CREEK	1.9	4.1	71d	5/1/2006	0.116	0.759
REF	DOW08074004	GARRISON CREEK	1.9	4.1	71d	3/24/2004	0.0303	0.437
REF	DOW08074002	GARRISON CREEK	1.4	4.5	71d	5/12/2009	0.0524	0.44
REF	DOW08074002	GARRISON CREEK	1.4	4.5	71d	4/28/2009	0.0742	0.659
REF	DOW08074002	GARRISON CREEK	1.4	4.5	71d	7/10/2006	0.0798	0.4361
REF	DOW08074002	GARRISON CREEK	1.4	4.5	71d	5/23/2007	0.103	0.541
REF	DOW08074002	GARRISON CREEK	1.4	4.5	71d	9/1/2009	0.0758	0.1602
REF	DOW08074002	GARRISON CREEK	1.4	4.5	71d	3/12/2010	0.0287	0.401
REF	DOW08074002	GARRISON CREEK	1.4	4.5	71d	11/5/2009	0.0725	0.936
						75^{th} percentile	0.079	0.600
						maximum	0.116	0.972

Table 3. Reference Reach monitoring nutrient data, ecoregion 71d, wadeble streams, all sample events

Program	Station	Stream	Mile	CA	Ecoreg	CollDate	TP mg/L	TN mg/L
REF	DOW04007003	INDIAN CREEK	0.55	5.6	71d	7/9/2004	0.102	0.418
REF	DOW04007003	INDIAN CREEK	0.55	5.6	71d	12/4/2003	0.0739	1.12
REF	DOW04007003	INDIAN CREEK	0.55	5.6	71d	3/25/2003	0.049	0.419
REF	DOW04007003	INDIAN CREEK	0.55	5.6	71d	10/21/1998	0.049	0.25
REF	DOW04007003	INDIAN CREEK	0.55	5.6	71d	6/20/1995	0.057	0.246
REF	DOW08057002	PRYORS FORK	0	8	71d	11/5/2009	0.005	0.523
REF	DOW08057002	PRYORS FORK	0	8	71d	3/12/2010	0.0102	0.1535
REF	DOW08057002	PRYORS FORK	0	8	71d	9/1/2009	0.005	0.1389
REF	DOW08057002	PRYORS FORK	0	8	71d	4/17/2009	0.005	0.254
REF	DOW08057002	PRYORS FORK	0	8	71d	4/11/2002	0.005	0.114
REF	DOW08057002	PRYORS FORK	0	8	71d	6/1/2009	0.0112	0.292
REF	DOW12004001	CEDAR CREEK	2.4	12.2	71d	6/1/2009	0.005	0.497
REF	DOW12004001	CEDAR CREEK	2.4	12.2	71d	6/22/2004	0.0207	0.472
REF	DOW12004001	CEDAR CREEK	2.4	12.2	71d	4/9/2009	0.005	0.865
REF	DOW12004001	CEDAR CREEK	2.4	12.2	71d	6/29/2009	0.0203	0.392
REF	DOW12004001	CEDAR CREEK	2.4	12.2	71d	8/25/2009	0.005	0.1564
REF	DOW12004001	CEDAR CREEK	2.4	12.2	71d	3/3/2008	0.0195	0.808
REF	DOW12004001	CEDAR CREEK	2.4	12.2	71d	5/31/2007	0.0217	0.76
REF	DOW12004001	CEDAR CREEK	2.4	12.2	71d	10/27/2009	0.005	0.864
REF	DOW12004001	CEDAR CREEK	2.4	12.2	71d	7/28/2006	0.0176	0.4193
REF	DOW12004001	CEDAR CREEK	2.4	12.2	71d	3/4/2010	0.005	0.621
REF	DOW12004001	CEDAR CREEK	2.4	12.2	71d	5/25/2006	0.102	1.52
REF	DOW04023002	MUDDY CREEK	13.4	37	71d	6/9/1994		0.363
REF	DOW04023002	MUDDY CREEK	13.4	37	71d	10/6/1994		0.105
REF	DOW04023002	MUDDY CREEK	13.4	37	71d	10/20/1992	0.249	0.112
REF	DOW04004001	DRENNON CREEK	10.5	41.8	71d	10/21/1998	0.127	1.294
REF	DOW04004001	DRENNON CREEK	10.5	41.8	71d	12/4/2003	0.132	1.49
REF	DOW04004001	DRENNON CREEK	10.5	41.8	71d	6/11/2002	0.212	1.55
						75^{th} percentile	0.070	0.822
						maximum	0.249	1.55

Table 4. Growing season geometric means at Floyds Fork, PRI100, 1999-2009

Year	TP mg/L	TN mg/L
1999	0.159	1.359
2000	0.150	1.154
2001	0.133	1.194
2002	0.111	1.426
2003	0.185	1.434
2004	0.173	1.729
2005	0.158	2.191
2006	0.173	1.676
2007	0.198	1.848
2008	0.126	1.720
2009	0.174	1.768
min	0.111	1.154
max	**0.198**	**2.191**

Table 5. Floyds Fork @ KY44 Water Column Chlorophyll-a, 2010-11

Date	chl-a (µg/L)
6/16/10	4.5
8/5/10	8.5
6/1/11	7.8
7/26/11	6.8
8/30/11	2.8

Table 6. Growing season geometric means at Beech Fork, PRI041, 1999-2009

Year	TP mg/L	TN mg/L
1999	0.089	0.672
2000	0.103	0.481
2001	0.131	0.401
2002	0.119	0.735
2003	0.329	1.386
2004	0.216	0.962
2005	0.124	0.707
2006	0.327	1.131
2007	0.228	1.081
2008	0.107	0.653
2009	0.243	1.445
min	0.089	0.401
max	0.329	1.445

Table 7. Growing season geometric means at Brashears Creek, PRI105, 1999-2009

Year	TP mg/L	TN mg/L
1999	0.149	0.643
2000	0.164	0.722
2001	0.189	1.138
2002	0.295	2.123
2003	0.663	2.436
2004	0.311	1.265
2005	0.196	0.806
2006	0.268	1.463
2007	0.226	1.391
2008	0.129	0.923
2009	0.256	1.555
min	0.129	0.643
max	0.663	2.436